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PROJECT: PIONEER A

SCHEDULED LAUNCH:

USE: PIONEER 6 SPACE PROBE

CONTENTS

TO BE LAUNCHED NO EARLIER THAN DEC. 15

(NASA-News-Release-65-375) NASA SCHEDULES FIRST IN NEW PIONEER SERIES (NASA) 48 p

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NEWS NASA
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NASA SCHEDULES
FIRST IN NEW
PIONEER SERIES

The National Aeronautics and Space Administration will begin a systematic exploration of interplanetary space this month with the launch of Pioneer A, first in a new Pioneer series.

The heavily-instrumented spacecraft is scheduled for launch from Cape Kennedy, Fla. no earlier than Dec. 15.

Pioneer A, to be designated Pioneer VI if successfully injected into solar orbit, and subsequent spacecraft in the series may be the only United States probe returning interplanetary data from space during the next several years. NASA's Mariner IV, which returned interplanetary data for 10 months and photographed Mars last July, is still operating but is not being tracked by ground stations. Mariner IV approaches Earth in 1967, however, at which time it may yield additional data.

The Pioneers will orbit the Sun in a strip of space about 40 million miles wide in the plane of the Earth's orbit. Some

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will travel in an orbit inside that of Earth's; others will be launched to regions beyond Earth's orbit.

Pioneer A will be launched in toward the Sun. Its eliptical orbit is expected to carry it to within about 77 million miles of the Sun after six months of flight. Its "year" is expected to be about 310 days long.

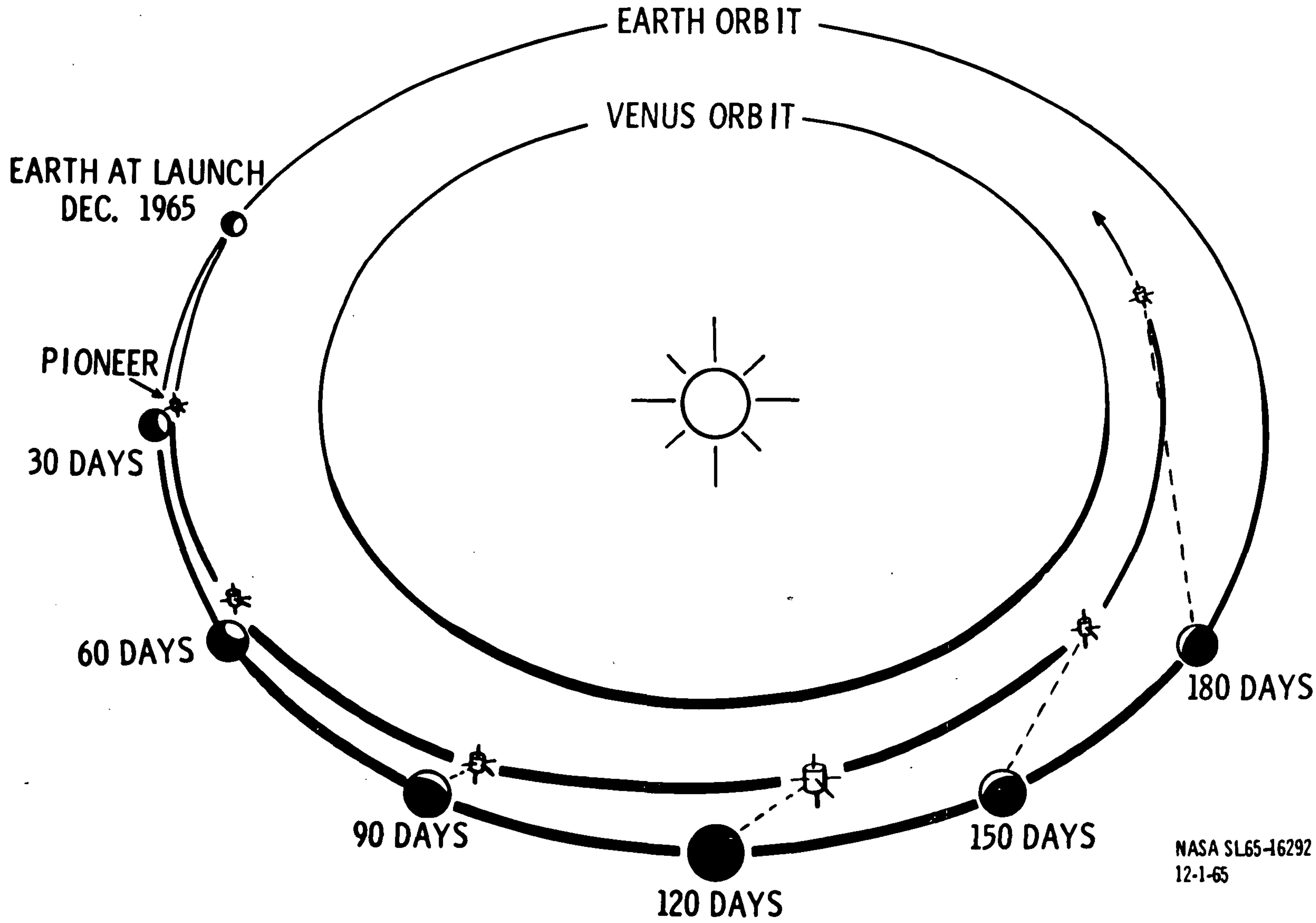
Data on interplanetary events will be obtained by measuring many types of atomic and sub-atomic particles and magnetic fields. Pioneer data also may improve understanding of the Sun. Combined with existing solar knowledge, information from the Pioneers should aid in determining the extent of the solar magnetic field and atmosphere.

The new Pioneer series bears the name of an earlier group of deep space probes, the last of which was Pioneer V, which returned data from 22.5 million from Earth in 1960.

The launch of Pioneer A will be by the Thrust-Augmented Improved Delta -- the second launch attempt for this vehicle and the first attempt by a Delta to launch a spacecraft into solar orbit.

Pioneers have the highest ratio of weight of scientific instruments to overall spacecraft weight of any interplanetary spacecraft. Pioneer A weighs 140 pounds and carries 35 pounds of scientific experiments.

PIONEER ORBIT



NASA SL65-16292
12-1-65

The Pioneer is the most "magnetically clean" spacecraft ever built in order to allow magnetometer experiments to sense interplanetary magnetic fields without interference from the spacecraft. The background spacecraft magnetic field is less than one hundred-thousandth of Earth's magnetic field.

Pioneer will be the first spacecraft to attempt a radio propagation experiment in interplanetary space.

It will also have the highest data-return capability of any interplanetary spacecraft and will be able to respond to 57 distinct ground commands.

Pioneer A is a cylinder 35 inches long and 37 inches in diameter. It will be spin-stabilized at about 60 revolutions per minute in the ecliptic (plane of the Earth's orbit) which will give its experiments a 360-degree scan while the 10,368 solar cells look at the Sun and its radio beam is alighed to Earth.

The six scientific experiments aboard Pioneer A are designed to improve our knowledge of:

-- the turbulent solar atmosphere or solar "wind" stream of charged particles

-- the magnetic fields of the Sun

-- the boundary region between the solar atmosphere and interstellar space

-- the physics of the Sun itself

-- the basic interactions of high-energy charged particles and magnetic fields

Some 14 months of interplanetary measurements have been provided by previous NASA missions -- Pioneer V, Explorers X and XVIII, and Mariners II and IV. Characteristics of the Sun change greatly over its 11-year cycle, however, so much additional information is needed.

The current Pioneer program got underway late in 1962 and is directed by NASA's Office of Space Science and Applications. Project management is assigned to NASA's Ames Research Center, Mountain View, Calif., the first time Ames has managed a space flight project.

The Improved Delta launch vehicle is managed by NASA's Goddard Space Flight Center, Greenbelt, Md., and is launched under direction of the Kennedy Space Center's Unmanned Launch Operations, Fla.

Communications and tracking will be by NASA's Deep Space Network which is operated by Jet Propulsion Laboratory, Pasadena, Calif.

The Pioneers are built by TRW Systems, Redondo Beach, Calif., and the Improved Delta was developed by Douglas Aircraft Co., Santa Monica, Calif.

The six scientific experiments were provided by four universities and the Ames and Goddard Centers.

(Background Information Follows)

PIONEER A SPACECRAFT

Overall Configuration

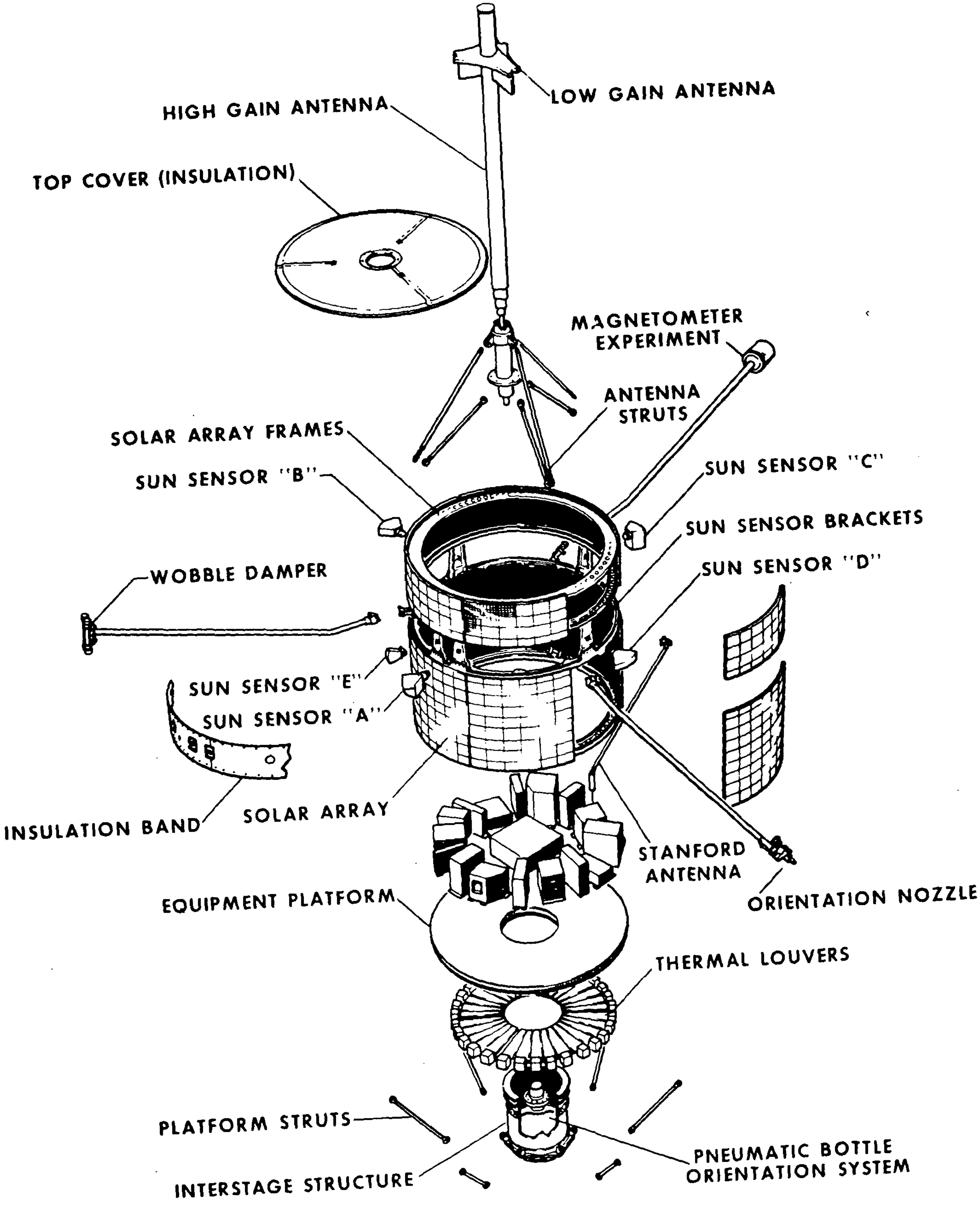
Pioneer was designed as a simple, rugged spacecraft to operate and return data for long duration flights at distances of many millions of miles from Earth.

The structure of the spacecraft, its subsystems and maneuvering operations all were chosen for simplicity and reliability. All orientation maneuvers, for example, are handled by just one cold-gas jet.

The Pioneer A spacecraft is a drum-shaped container, 35 inches high and 37 inches in diameter, enclosing scientific experiments, communications, data handling, and orientation control systems, plus electric power and temperature control equipment. It weighs 140 pounds, including 35 pounds of scientific instruments.

Its cylindrical exterior is covered with solar cells divided by a narrow circular band containing apertures for four experiments and four orientation Sun sensors. A fifth Sun sensor provides the experiments a continuous directional reference to the Sun's position.

PIONEER A SPACECRAFT COMPONENTS



Projecting from the center of the one end of the cylinder is a four-foot, four-inch long rod, the upper quarter of which contains two low-gain antennas, the lower three quarters a high-gain antenna. Extending downward from the cylinder on the end opposite the communication boom is another rod-shaped antenna to receive signals for the Radio Propagation Detector, one of the scientific experiments.

At 120-degree intervals around the sides of the spacecraft are three five-foot, four-inch long booms. These are folded up against the antenna during launch and deployed horizontally in flight by the spin of the spacecraft. One boom carries a gas jet at its end to change spacecraft attitude. A second is tipped by a "wobble damper" to eliminate wobbling rotation. A third boom carries a magnetometer at its tip.

Within the cylindrical spacecraft is a circular platform on which are mounted most of the electronics equipment and experiments. Below this platform are narrow pie-shaped, heat-control louvers, and a pressure cylinder containing gas for the orientation system.

The spacecraft structure, made principally of aluminum, is lightweight and its cylindrical shape is inherently strong. There are more than 56,000 parts in Pioneer A including its scientific instruments.

Communications System

Pioneer A will maintain two-way radio communication with the Deep Space Network (DSN) at about 2300 megacycles on S-band.

Commands go out from the DSN antennas in the form of binary code, and are handled on the spacecraft as follows: Commands are received either by the low-gain or high-gain antenna, and are routed to one of two redundant radio receivers. They then go to one of two command decoders. Once decoded, each command is routed by the command distribution unit eit to a spacecraft system or an experiment, where it is carried out. The spacecraft has a capability to receive 57 separate commands.

To send information back to Earth, the spacecraft driver puts coded data on the basic S-band carrier and routes it to one of the two spacecraft traveling wave tubes, which amplifies the signal to about eight watts. From here the signal goes to the high-gain antenna which transmits it to the big-dish antennas of the DSN.

The spacecraft low-gain antennas transmit a broad beam covering an angle of about 125 degrees in a full circle. The high-gain antenna transmits a beam covering only a five-degree angle in width, but also sent out in a full circle. If the narrow-beam antenna should drift from the Earth during the first 10 million miles, the broad-beam, low-gain antenna can

take over until the spacecraft is repositioned.

Pioneer A will have the greatest data return capacity of any interplanetary spacecraft because it can match the most efficient rate of data return to its distance from the Earth. It can return data at five speeds: 512, 256, 64, 16 and 8 bits per second.

Data can be sent in four basic forms: (1) measurements from scientific experiments only, (2) high resolution measurements from the Radio Propagation Detector only, (3) engineering measurements of spacecraft performance only, and (4) limited samplings of engineering data superimposed on science data.

All data are sent in binary code, forming six-bit "words". Words are arrangements of 1's and 0's. For example, the word "110010" is the number 50. Scientific and engineering data are handled in 32- and 64-word frames. Periodic code words identify the part of the frame being sent.

The spacecraft data storage unit can receive up to 19 hours of selected information from experiments and store it for later transmission. It is a compact, solid-state memory core with no moving parts. Its 15,232 bits of information storage provide 2,176 data words in 68 frames.

The data telemetry unit turns spacecraft data into binary code for transmission to Earth. It receives information from the data storage unit or directly from experiments and equipment.

Attitude Control

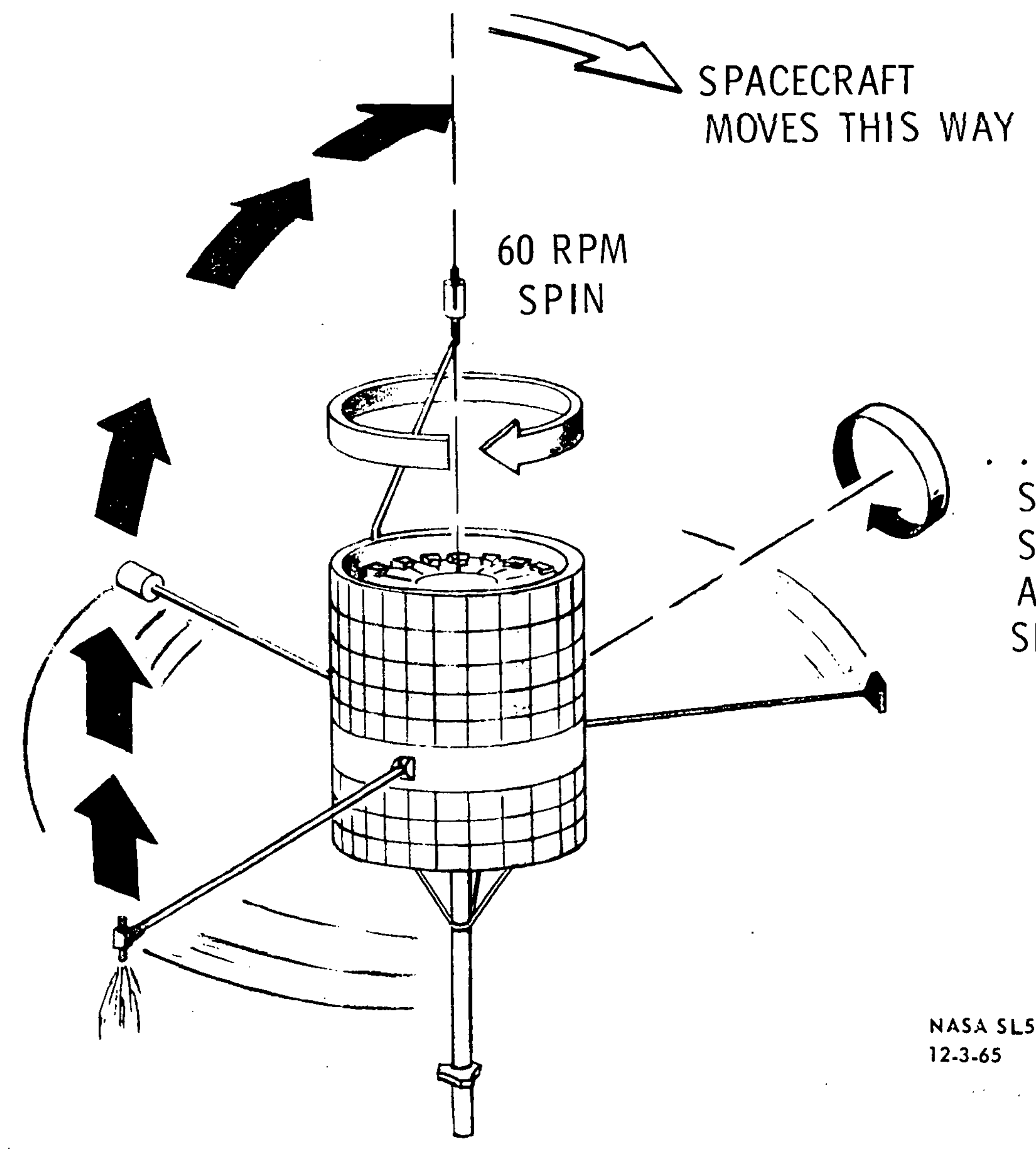
Throughout its mission, Pioneer A will use the gyroscopic effect of its 60 rpm rotation to maintain a stable attitude.

Changes in position are achieved by turning the spacecraft about an axis through many bursts from the nitrogen gas jet at the end of one boom. Force from the gas jet must be applied perpendicular to the desired direction of motion because the spinning craft precesses like a gyroscope.

Each thrust is applied for only a quarter of a second at just one point on the circle of spacecraft rotation. Thrusts are timed by Sun sensors which see the Sun once each spacecraft revolution and each thrust turns the spacecraft only three-tenths of one degree. The many thrusts required at just one point produce wobbling rotation. Wobble is eliminated by the wobble damper at the end of one boom. Two small balls float in fluid inside a cylinder. The friction of the balls moving through the fluid changes the kinetic energy of the wobble movement into heat which is dissipated. All three spacecraft booms are flexible to help counteract wobble.

PIONEER ORIENTATION MANEUVERING

SHORT THRUSTS
AGAINST SPIN
AXIS BRING
FORCE TO BEAR
IN A PLANE
PERPENDICULAR
TO DIRECTION
OF THRUSTS
(GYROSCOPE
EFFECT) . . . .



. . . . AND TURNS
SPIN AXIS (AND
SPACECRAFT)
ABOUT A
SELECTED AXIS

NASA SL56-16298
12-3-65

To operate properly, Pioneer A must have its spin axis perpendicular to both Sun-spacecraft line and Earth-spacecraft line, so that solar cells are efficiently illuminated and the narrow beam of the high-gain antenna strikes the Earth.

The Sun-orientation maneuver is expected to take place shortly after Pioneer achieves orbit. Earth orientation is planned for some three days later to focus the high gain antenna at Earth, essential for Pioneer to be heard by ground stations beyond 10 million miles.

Reference points and timing for placing the spacecraft in this position are provided by four Sun sensors. To orient itself perpendicular to the Sun, Pioneer A uses two sensors. One can see the Sun for 80 degrees above the plane of spacecraft rotation, another for 80 degrees below this plane. When one of these two sensors sees the Sun, logic circuits turn the spacecraft so that the other sensor will also see the Sun.

Turning stops when both sensors see the Sun, and hence spin axis is nominal to the spacecraft-Sun line.

To position the spacecraft perpendicular to the plane of the Earth's orbit so that its narrow-beam radio signal strikes the Earth, ground commands must rotate it around the spacecraft-Sun line.

Controllers will first make a short trial rotation around the Sun line and calculate proper direction of rotation from resulting changes in the pattern of the incoming radio signal.

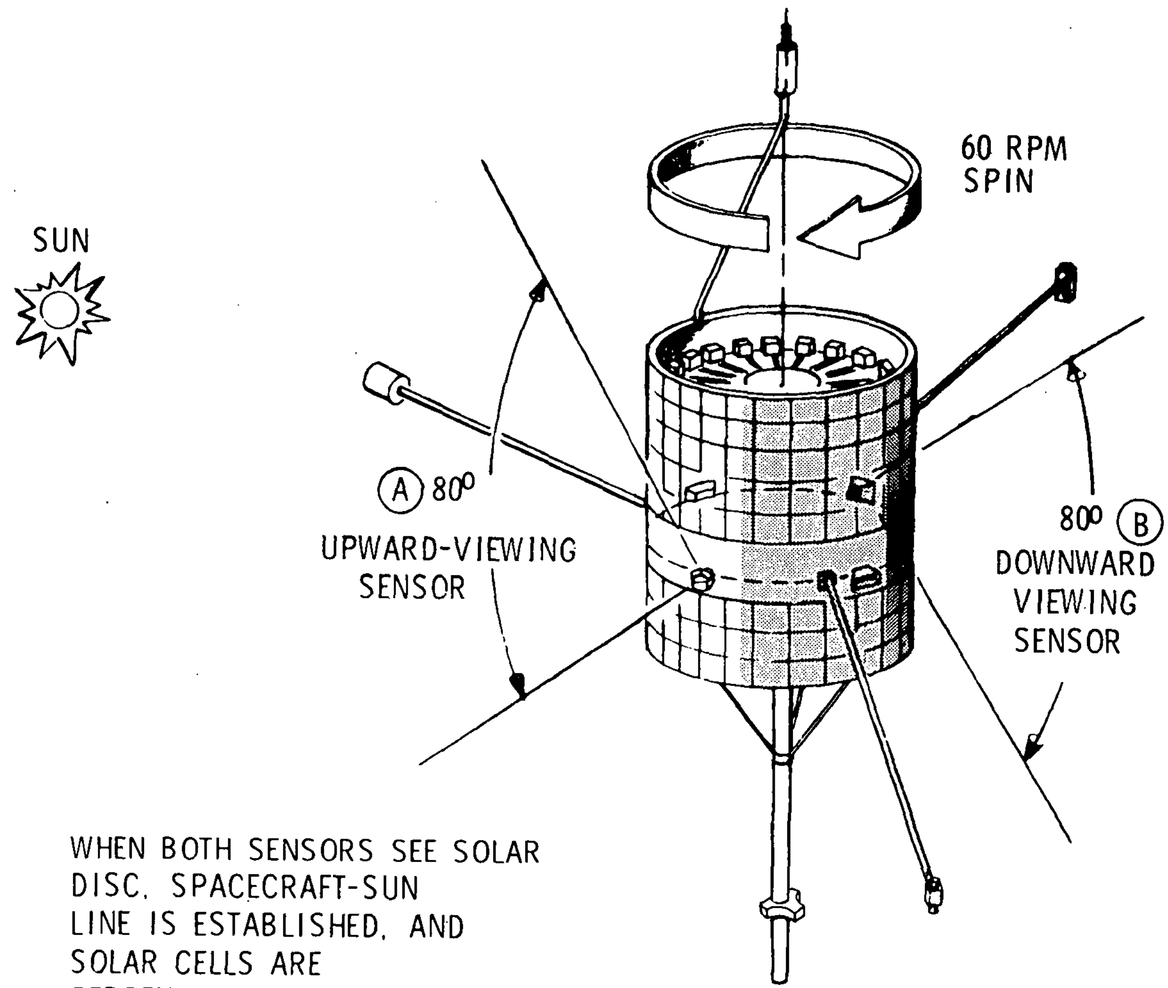
Once the spacecraft has rotated until it acquires the Earth, it can be oriented precisely by halting rotation at the point where peak power is received from the high-gain antenna.

The remaining two Sun sensors provide timing for gas jet thrusts to make the Earth orientation maneuver.

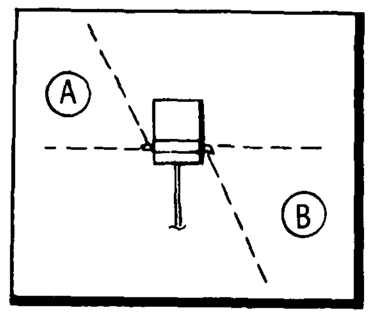
Power System

Pioneer's 10,368 silicon crystal, n-on-p solar cells will provide about 80 watts of power at Earth's distance from the Sun, and additional power will be available as the spacecraft approaches the Sun. About 30 watts will be required for telecommunications, 10 watts for experiments, and 15 watts for other equipment. Required voltages for individual systems, ranging from three to 12,000 volts will be provided by nine voltage converters, and power for all equipment and experiments will be supplied from a 28-volt main bus.

PIONEER SUN ACQUISITION



WHEN BOTH SENSORS SEE SOLAR
DISC, SPACECRAFT-SUN
LINE IS ESTABLISHED, AND
SOLAR CELLS ARE
PERPENDICULAR TO SUN'S RAYS.



NASA SL65-16230
12-3-65

Auxiliary power is provided by a rechargeable silver-zinc battery with a life of about an hour without recharging, during operation of the low-power radio. The battery will be used primarily during launch before solar cells begin to provide power.

Temperature Control

Temperature aboard Pioneer will be controlled by managing the internal heat produced by equipment and by heat-reflective coatings on the surface of the spacecraft to ward off heat radiation from the Sun.

Twenty louvers under the spacecraft equipment platform, actuated by bimetallic springs, will open and close automatically to release enough heat from the spacecraft interior to maintain proper temperatures at specific locations.

Magnetic Field

The magnetic field of the Pioneers is one-half gamma at 80 inches from the center of the spacecraft, making the spacecraft magnetically the cleanest ever built. The Earth's surface measures 50,000 gamma and up to 70,000 gamma at the poles.

Engineers achieved this low magnetism by using non-magnetic materials throughout, particulary plastics, non-ferrous metals, and certain types of wire as well as new fabrication and inspection techniques, and design innovations for low magnetism.

SCIENTIFIC INVESTIGATIONS

Interplanetary space is often regarded as a huge void, and, in fact, it is an extremely tenuous medium with pressures or densities hundredths of thousandths less than have been obtained in the best laboratories on Earth. Nevertheless, space between the planets constitutes a medium through which solar and galactic events propogate and greatly influence our terrestrial environment.

The physical extent of these disturbances and the conditions which they create is much larger than the orbits of Earth satellites or even lunar probes, and their variations over an 11-year solar cycle call for more continuity of measurement.

Known phenomena in interplanetary space generally divide into the following categories:

Particles: electrons and hydrogen and helium nuclei carrying an electrical charge which make up the "solar wind;" cosmic rays which are extremely fast moving or energetic charged nuclear particles of many elements; and cosmic dust and meteoroids.

Radiation: the entire electromagnetic spectrum such as light, radio, and X-rays.

Fields: magnetic, electric, and gravitational.

The six Pioneer A experiments fall into these areas of study:

- a magnetic field investigation (Single Axis Magnetometer)

- investigation of the solar wind (Plasma Cup Detector, Quadrispherical Plasma Analyzer, and Radio Propagation Detector)
- cosmic ray studies (Cosmic Ray Anisotropy Detector and Cosmic Ray Telescope).

Magnetic Field Investigation

The character of the Sun's magnetic field is known only in part. It may be somewhat like the Earth's magnetic field, generally a distorted doughnut-shape with lines of force coming out of one pole, curving through space, and reentering at the other pole.

But this picture is complicated by several factors. Charged particles of the solar wind are believed to flow constantly outward in all directions, carrying the solar magnetic field with them, and forming a spiral magnetic structure as the solar wind moves out from the rotating Sun.

The Sun's magnetic field varies during the 11-year solar cycle and may even reverse its polarity every solar cycle.

At times there appear to be relatively small, intensely magnetic regions on the Sun with thousands of times the average strength of the solar magnetic field. And huge tongues of ionized gas emitted from the Sun (solar storms or flares) carry their own field along with them.

Single Axis Magnetometer - Goddard Space Flight Center

The objective of this experiment is to chart the Sun's magnetic field from many locations in the plane of the Earth's orbit (the ecliptic).

The experiment sensor is mounted on a boom five feet from the spacecraft to minimize interference from Pioneer's tiny magnetic field.

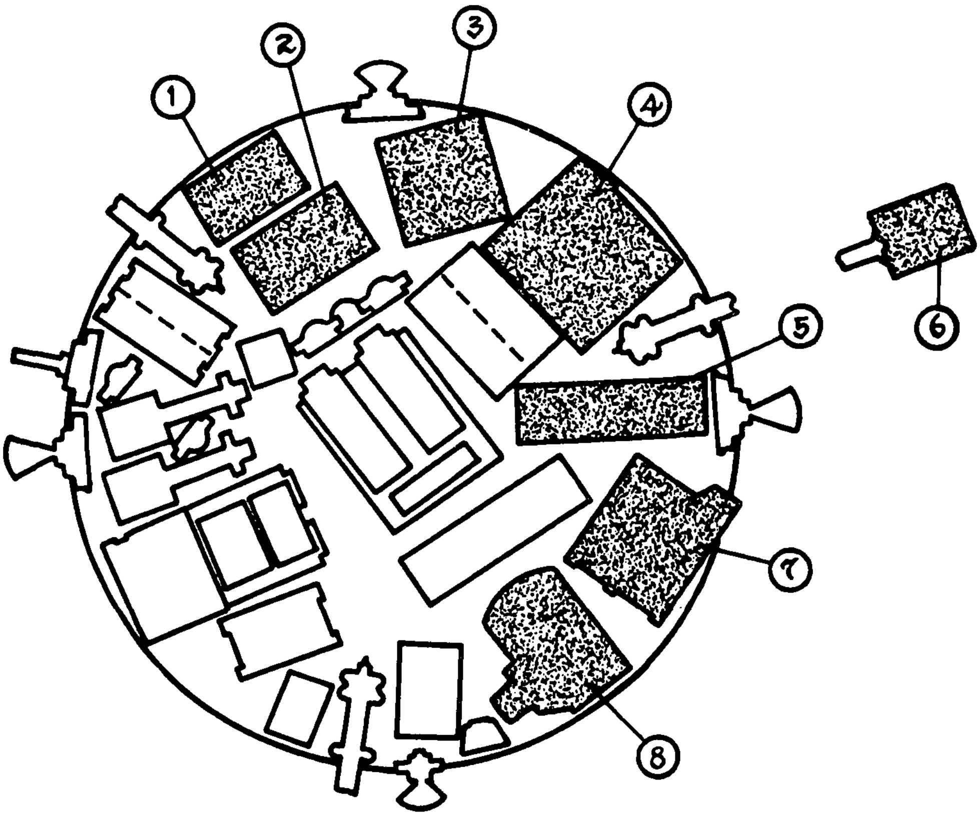
The experiment uses a single fluxgate sensor, a device which employs a magnetic core and electronic circutry to measure the magnetic field along the axis of the sensor.

The sensor is oriented at about 55 degrees to the spin axis of Pioneer and takes three readings for each rotation of the spacecraft. Because the axes at the time of these three measurements are perpendicular to each other, they enable one to compute the strength and direction of the magnetic field.

The magnetometer can sense magnetic field strengths from plus 64 gamma to minus 64 gamma (at its surface, the Earth's magnetic field is about 50,000 gamma). It has a sensitivity of one quarter gamma or one 200,000 of the Earth's field.

The experiment weighs 5.3 pounds and uses 0.9 watts of power.

PIONEER A SCIENCE EXPERIMENTS ARRANGEMENT



1. Plasma Cup Detector (sensor) - Massachusetts Institute of Technology

2. Plasma Cup Detector (electronics)

3. Radio Propagation Detector - Stanford University

4. Cosmic Ray Telescope - University of Chicago

5. Single Axis Magnetometer (electronics) - Goddard Space Flight Center

6. Single Axis Magnetometer (sensor at end of five-foot long boom)

7. Quadraspherical Plasma Analyzer - Ames Research Center

8. Cosmic Ray Anisotropy Detector - Graduate Research Center of the Southwest.

Solar Wind Studies

An ionized or electrically charged gas boils off from the Sun's gravitational field at supersonic speeds. This thin moving gas is known as the solar plasma or solar wind and is believed to be made up of hydrogen ions, helium and other ions, and electrons.

Many scientists regard the solar plasma as a dominant factor in interplanetary space because it shapes magnetic fields which in turn deflect cosmic rays and the Earth's magnetic field.

Three experiments on Pioneer A will gather data on these ionized particles coming from the Sun, their quantities, energies, and directions.

Plasma Cup Detector -- Massachusetts Institute of Technology

This experiment is designed to measure the number, density, direction and energy of positive ions and electrons in the solar wind.

The detector is a Faraday cup with fine tungsten wire grids through which particles must pass to reach a collector plate. Systematic varying voltages on the grids allow the passage of particles in a sequence of 20 energy ranges.

At the energy range being measured, the particles create an electric current which is a measure of the number of particles in each energy range in turn.

Because the spacecraft is spinning, the direction of the incoming particles in the plane of rotation is measured by noting in which direction the probe looks at any instant. The collector is split into upper and lower halves to measure direction of incoming particles in the vertical plane.

This instrument measures electrons with energies from 500 to 2500 electron volts and hydrogen nuclei from 40 to 10,000 electron volts. It can measure particles ranging in density from 400,000 to four billion particles per square centimeter per second.

The experiment weighs 6.1 pounds and requires an average of 2.5 watts of power with peaks of 10.7 watts.

<u>Quadrispherical Plasma Analyzer</u> -- <u>Ames Research Center</u>

This experiment is designed to measure particles in the solar wind -- quantities, directions, energies and temperatures.

It gets its name from the fact that the instrument is made up of two curved plates, one fitting over the other, which represent one-quarter of a sphere. A voltage across the plates is varied to select particles in a sequence and particles being measured at any moment pass between the plates and land on a collector. It produces a current showing the number of particles arriving in each energy range in turn.

Horizontal direction of the particles is measured by noting the direction in which the probe is looking out from the spinning spacecraft at the time of arrival of particles. Vertical direction is measured by eight collector plates which look out in eight directions over a 160 degree arc.

The experiment measures electrons with energies from two to 500 electron volts and positive ions with energies from 200 to 10,000 electron volts. It can measure from 50,000 to 100 million particles per square centimeter per second. It weighs 6.3 pounds and uses 1.6 watts of power.

Radio Progation Detector -- Stanford University and Stanford Research Institute

The objective of this experiment is to determine the variations in total electron content in the space between Pioneer and Earth.

A 150-foot dish antenna at Stanford University in Palo Alto, Calif., will be used to send radio signals at two different frequencies to a special antenna and receiver on the spacecraft.

The speed of radio transmissions are affected by the electrons of the solar plasma and depends on the frequency of the radio signal. A high frequency signal (423.3 megacycles) will be sent as a reference and experimenters will then compare the relative phase and delay of receipt of the low frequency signal (49.8 megacycles) to make total electron content calculations.

These calculations will be useful in detecting sudden increases in electron density resulting from solar flares, and the data may also be used to refine measurements of Pioneer's position in space.

The experiment and antenna weigh 6.0 pounds and require 1.6 watts of power.

Cosmic Ray Studies

Cosmic rays are extremely high energy charged nuclear particles moving through space. They are thought to originate from both the Sun and from interstellar sources. Most of the particles are hydrogen nuclei but some are helium nuclei and nuclei of the heavier elements.

The Pioneer A experiments will attempt to differentiate between cosmic rays coming from the Sun and galactic cosmic rays originating from interstellar space far beyond our solar system.

Solar cosmic rays are present in interplanetary space principally during solar storms and probably originate from small disturbed areas on the Sun/

Galactic cosmic ray particles are far fewer than solar cosmic ray particles during solar storms and they seem to come from all directions in space while solar cosmic rays come largely from a single area. In addition, galactic particles have far higher energies than solar cosmic rays with occasional galactic rays reaching almost the speed of light, giving them tremendous energies.

The Pioneer cosmic ray experiments should add to understanding how both solar and galactic cosmic rays are produced and propagated through the solar system.

Cosmic Ray Anisotropy Detector -- Graduate Research Center of the Southwest

The objective of this experiment is to measure the characteristics of both solar and galactic cosmic rays.

It gets it name from the fact that the experiment will be directional or anisotropic: it will be able to measure differences in the number of galactic cosmic ray particles arriving from various directions and to determine whether the mass and energy of these particles arriving at the spacecraft vary with incoming direction.

In past experiments, scientists have found variations of around one percent in the number of galactic rays arriving from various directions. Study of these differences could provide information about the nature of the boundary region between the solar and interplanetary magnetic fields.

The experiment consists of a crystal scintillator which produces flashes of light of varying intensity depending on the energy, direction and type of cosmic ray particle which strikes its crystal lattice.

An anticoincidence scintillator, two photomultiplier tubes which translate the flashes into electric impulses to radio to Earth, and other electronics will categorize the cosmic ray particles and their directions.

As the spacecraft spins, the instrument detects particles arriving from four different directions in space. It uses the Sun as a reference point in computing the incoming directions of the cosmic rays.

The energy range for hydrogen nuclei is from 7.5 million to 90 million electron volts and for helium nuclei from 130 million to 360 million electron volts.

The instrument weighs 4.4 pounds and requires an average of 1.8 watts of power.

Cosmic Ray Telescope -- Fermi Institute, University of Chicago

This experiment is designed to measure both solar and galactic cosmic rays.

In measuring galactic cosmic rays, scientists are interested in variations of energy and composition of the particles as the spacecraft moves near the Sun. They also want to determine if the distribution of galactic cosmic particles changes with time as the level of the Sun's activity increases during the current solar cycle.

It has been inferred that the Sun's magnetic field indirectly affects the number of low energy galactic cosmic rays arriving at Earth and these measurements are expected to provide information on the nature and extent of the solar magnetic influence within the solar system.

The experiment also will attempt to determine numbers and energies of hydrogen and helium cosmic ray particles arriving from interstellar space and it may provide clues as to what interstellar forces have accelerated these hydrogen and helium nuclei.

The experiment will use solid state detectors which produce electric impulses of varying strength depending on energy, direction and type of charged particle passing through their atomic structures.

Equipment includes three solid state detectors, a cesium-iodide scintillator tube, and associated electronics. The instrument looks out in a 60 degree cone and in a full circle as the spacecraft spins.

It will measure hydrogen and helium nuclei with energies from one million to 200 million electron volts.

The instrument weighs 4.7 pounds and will require about 1.2 watts of power.

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IMPROVED DELTA LAUNCH VEHICLE

The Pioneer mission will require the most ambitious flight trajectory in the five-year history of Delta launchings from Cape Kennedy.

The 92-foot tall Delta with an enlarged upper stage also will carry three strap-on solid rockets on its first stage to give it a lift-off thrust of 333,550 pounds. Delta, the 35th to be launched, will undergo a countdown of 14 hours and 40 minutes at Complex 17 before lifting-off on an azimuth of 101 degrees from true North.

Earlier Deltas used line-of-sight radio commands to command second stage cut-off. Delta 35 will go over Cape Kennedy's horizon about seven minutes after lift-off so a radio command at that time will set an accelerometer in the second stage to activate the cut-off system.

Thrust-Augmented Delta Characteristics

Height:	92 feet (includes shroud)
Maximum Diameter:	8 feet (without attached solids)
Lift-Off Weight:	about 75 tons
Lift-Off Thrust:	333,550 (includes strap-on solids)

First Stage (liquid only):

	Modified Air Force Thor, produced by Douglas Aircraft Co., engines produced by Rocketdyne Division of North American Aviation
Diameter:	8 feet
Height:	51 feet
Propellants:	RP-1 kerosene is the fuel and liquid oxygen (LOX) is the oxidizer for the Thor stage
Thrust:	172,000
Burning time:	About 2 minutes, 45 seconds
Weight:	Approximately 67 tons (including solids)
Strap-on Solids:	Three solid propellant rockets produced by the Thiokol Chemical Corp.
Diameter:	31 inches
Height:	19.8 feet
Weight:	27,510 (9,170 each)
Burning Time:	43 seconds
Second Stage:	Produced by the Douglas Aircraft Co., utilizing the Aerojet General Corp., AS110-118 propulsion system.
Propellants:	Liquid--unsymmetrical dimethyl hydrazine (UDMH) for the fuel and red fuming nitric acid for the oxidizer.
Diameter:	4.7 feet (compared to 2.7 feet for the earlier Deltas)
Height:	16 feet
Weight:	6½ tons (compared to 2½ tons for the earlier Deltas)
Thrust:	About 7,800 pounds
Burning Time:	400 seconds (compared to 150 seconds for earlier Deltas)
Guidance:	Western Electric Co.

Third Stage:	Allegany Ballistics Laboratory X-258 motor.
Propellants:	Solid
Height:	3 feet
Diameter:	$1\frac{1}{2}$ feet
Weight:	570 pounds
Thrust:	6,414 pounds
Burning Time:	23 seconds

Nominal Delta Flight Events

EVENT	IGNITION (seconds)	BURN OUT (seconds)	ALTITUDE (miles)	SURFACE RANGE (miles)	VELOCITY (mph)
Strap-on solids	T minus 0	+43	$4\frac{1}{2}$	2	1,760
First stage (Thor)	T minus 0	+147	55	104	9,500
Second stage	T + 154	+551	172	1,363	17,960
Third stage	T + 1501	+1524	346	5,650	24,200

THE DEEP SPACE NETWORK

The Deep Space Network (DSN) consists of six permanent space communications stations, a launch monitoring and spacecraft checkout station at Cape Kennedy, the Space Flight Operation Facility (SFOF) in Pasadena Calif., and a ground communications system linking all locations.

The DSN is under technical direction of the Jet Propulsion Laboratory for NASA. Its mission is to track, receive telemetry from and send commands to lunar, planetary, and interplanetary spacecraft from the time they are injected into orbit until they complete their missions.

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During launch, Delta will be tracked by Eastern Test Range stations at Cape Kennedy, Antigua, Grand Turk, Grand Bahama Islands, Ascension, Pretoria and a tracking ship in the South Atlantic.

Tracking data obtained during launch will be computed both at Cape Kennedy and at the SFOF so that accurate predictions can be sent to the DSN stations of where Pioneer will appear on their horizons.

The permanent DSN stations provide 360-degree coverage around the Earth, so that one or more of their 85-foot dish antennas can always "see" the spacecraft.

Three permanent DSN stations will be used for Pioneer. The Echo station at Goldstone, Calif., and the Tidbinbilla station near Canberra, Australia, will be the prime stations. The station at Johannesburg, South Africa, will track during the first four days of the mission. All have 85-foot diameter receiving antennas and 10,000-watt transmitters.

For the Pioneer A mission, the DSN will monitor the spacecraft as follows: continuously for the first four days; for around 18 hours a day from Goldstone and Tidbinbilla during the next 26 days; and for from nine to 11 hours daily from either Tidbinbilla or Goldstone for the rest of the mission.

For Pioneer, the DSN stations have been equipped with special command encoders to code commands for transmission to the spacecraft. Other station equipment for Pioneer includes:

demodulators and synchronizers to translate spacecraft telemetry and Pioneer computer programs for station computers.

The DSN tracks the spacecraft using two-way Doppler, which works generally as follows:

A signal is sent from the DSN antennas at a precisely known frequency, and a transponder aboard the spacecraft returns it at a frequency increased by an exact ratio. Motion of the spacecraft away from the Earth causes both frequencies, as they are received, to shift slightly downward. The total frequency shift both going and coming is used to calculate the average one-way shift.

Since the frequency of this signal is precisely known, this average Doppler shift can be used to calculate velocity to a few feet per second, despite distances of millions of miles. From velocity measurements, exact spacecraft orbit and distance from Earth also can be derived.

Scientific and engineering measurements radioed from the spacecraft will be received and recorded on tape at the tracking stations. A computer checks the data and "strips off" 15 to 20 percent quick-look engineering information. Quick-look data is then transmitted to the Space Flight Operations Facility via teletype from overseas and microwave radio from Goldstone to be used for daily operations.

The complete tape of data received from the spacecraft will be mailed to the SFOF for checking and duplication and then sent to the Ames Center. There it will be processed at the Pioneer Data Reduction Center, and be distributed to experimenters, contractors, and project personnel.

The nerve center of the Net is the Space Flight Operations Facility at Pasadena. The DSN stations are linked to the SFOF by a ground communications network, operated by the Goddard Center overseas and the DSN in the U.S.

The SFOF, designed for 24-hour functioning and equipped to handle two spaceflight missions concurrently while monitoring a third, will be manned by some 50 people during the Pioneer mission. This group will be divided about evenly among Ames Research Center, DSN, and TRW Systems personnel.

Mission control personnel are supported by three technical teams. The DSN Flight Path Analysis Group is responsible to evaluate tracking data and determine flight path of the spacecraft.

The Pioneer Project Space Science Analysis Group is responsible for evaluating data from experiments, and to generate commands controlling the experiments.

The Pioneer Spacecraft Performance Analysis Group evaluates the condition of the spacecraft from quick-look engineering data

radioed to Earth and generates commands to the spacecraft affecting its performance.

FLIGHT SEQUENCE

These are the planned events in the Delta 35/Pioneer A mission:

The main Delta engine and three solid strap-on motors fire together. The solid motors burn for 43 seconds and their burned-out casings are jettisoned at 70 seconds after launch. The main engine burns out after two minutes and 45 seconds.

After two minutes and 55 seconds, the Delta second stage ignites and, one second later, the first stage separates and falls away. The shroud covering the spacecraft is jettisoned at two minutes and 59 seconds.

The second stage burns for some six-and-two-thirds minutes with burnout a little more than nine minutes after launch. After second stage burn out, the second stage coasts for some 16 minutes.

About 10 minutes after launch, during the coast phase, the vehicle is pitched down to point in the precise direction for injection of the spacecraft into solar orbit.

The pitching maneuver lasts about five minutes. Control

during the coast phase of the second stage is by cold gas jets.

At the end of the coast phase, the spin-up table in the nose of the second stage begins to revolve from the thrust of four small rockets, spinning both third stage and spacecraft, to assure that both will travel in the precise direction established by the second stage pitch-down. The spacecraft retains this stabilizing spin for the life of the mission.

Nine seconds after spin-up, the third stage separates from the second stage, and four seconds later, the third stage ignites and burns for 23 seconds.

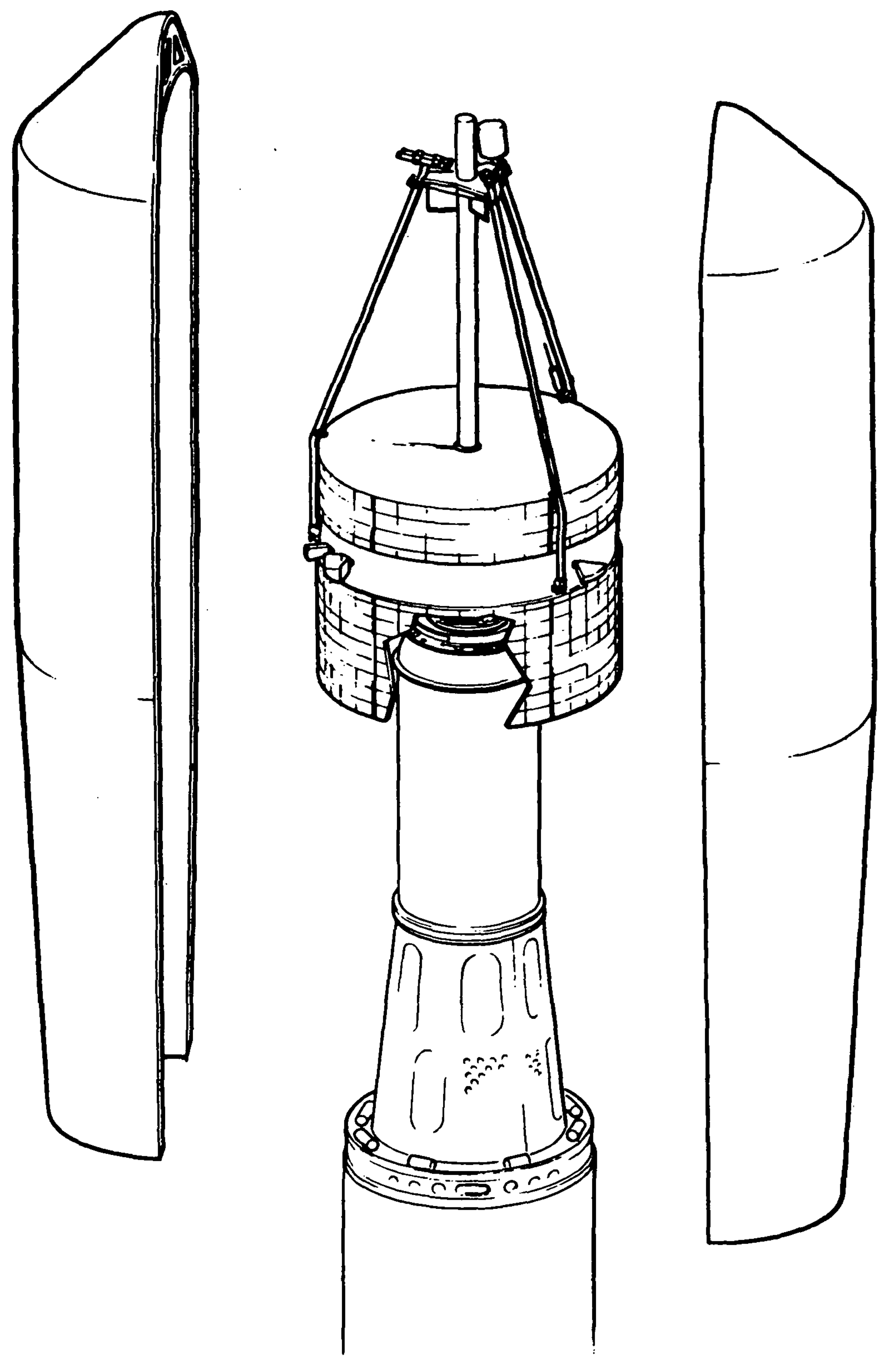
Two seconds after third stage burn-out, Pioneer separates from the burned out stage 346 miles above Africa, some 4900 miles from Cape Kennedy.

Pioneer now is injected into a solar orbit.

Two seconds after third stage separation (about 25 minutes after launch), the spacecraft booms automatically deploy. At the same time, automatic changes in spacecraft attitude begin to orient the spacecraft covered with solar cells perpendicular to the Sun.

Sun orientation is critical to survival of the spacecraft. Without power from its solar cells, spacecraft batteries would fail within around an hour. The Sun orientation maneuver is expected to take about five minutes.

PIONEER A - MOUNTED ON DELTA THIRD STAGE



The high power amplifier for the spacecraft radio turns on immediately after third-stage separation. sending out a wide beam signal via the spacecraft's low-gain antenna.

About 35 minutes after lift-off, first acquisition by the DSN tracking station at Johannesburg occurs. Condition of the spacecraft is checked via incoming telemetry and all spacecraft systems are checked out. A key task is to check solar cell operation and electric power output. Within the first three hours after launch, this checkout process is expected to be complete.

Johannesburg also is planned to start the crucial Earth acquisition by ground command and to continue it long enough to assure that the spacecraft's low-gain antenna are pointed toward the Earth to maintain a strong, two-way radio signal. This process is expected to take up to three days.

After this is completed, if the spacecraft drifts from either Sun or Earth orientation, commands will be sent to reacquire.

During the first three hours, the six scientific experiments are planned to be turned on, one at a time.

At about 14 hours after launch, the first scientific data from the Radio Propagation Detector is expected to be sent from Goldstone to Stanford University at Palo Alto Calif.

Experimenters there will begin a process which will continue throughout the mission. They will send radio signals from Stanford's 150-foot dish antenna directly to the Stanford radio receiver aboard the spacecraft.

The spacecraft will return data on the Stanford signal to Goldstone, which will forward it to Stanford. There then begins a continuous process in which each Stanford communication to its spacecraft receiver is based on the latest data returned from its scientific experiment aboard Pioneer.

For the next six months, the spacecraft's scientific experiments will make their interplanetary measurements and report them to Earth.

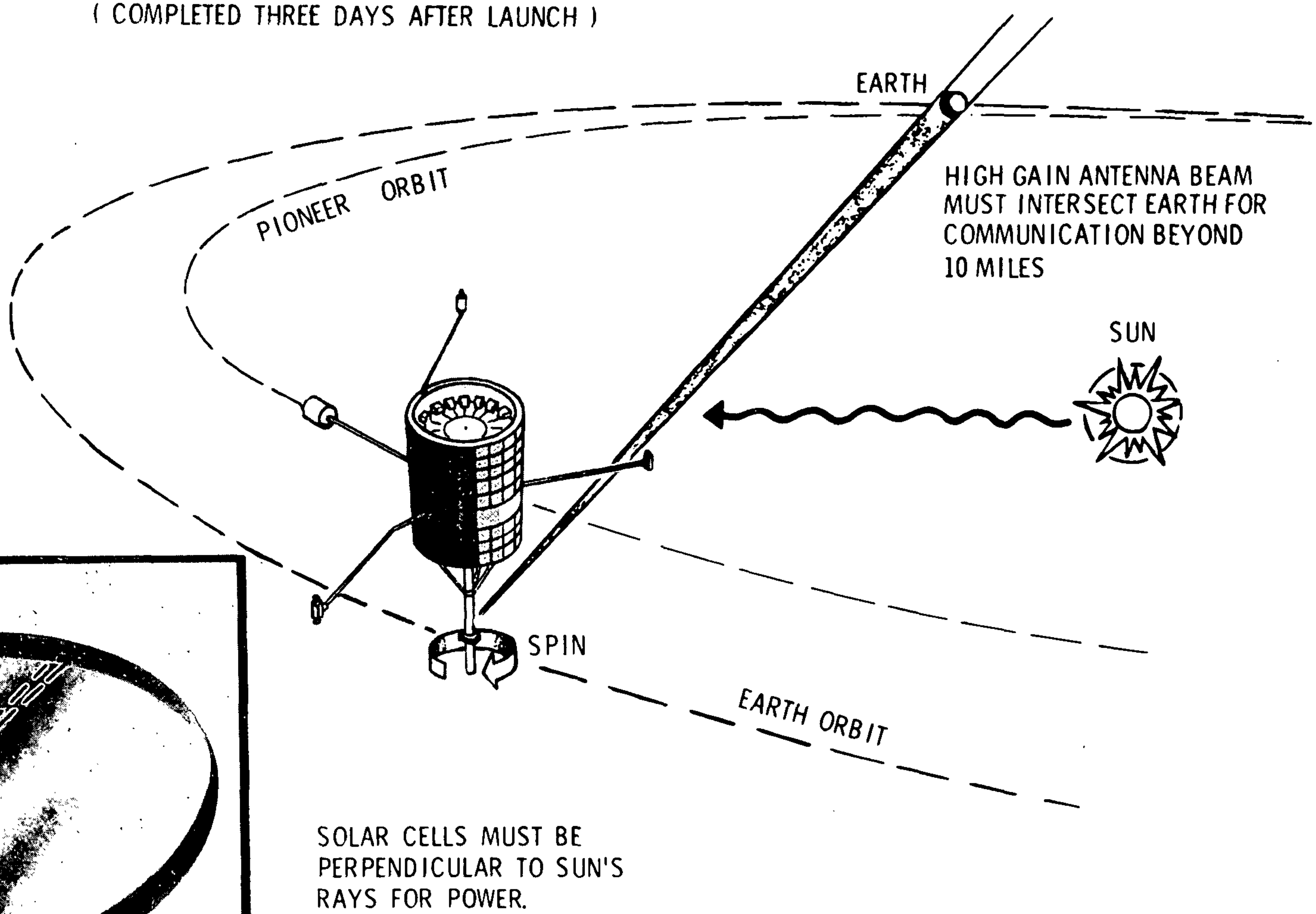
After the first few weeks, the DSN is planned to track the spacecraft for only one pass a day of around 10 hours. at either Goldstone or Canberra.

For this partial tracking, Pioneer A uses its memory system to store up to 19 hours of data. When contact with the spacecraft is resumed each day, it is first commanded to send this stored data. After this, the spacecraft reports in real time for the rest of the pass.

About 75 days after launch, to get a clearer signal, it is planned for Pioneer to shift its rate of transmitting information

PIONEER EARTH/SUN ACQUISITION

(COMPLETED THREE DAYS AFTER LAUNCH)



HIGH GAIN BEAM RADIATES 360° FROM ANTENNA. BEAM IS 5° WIDE.

NASA SL65-16299
12-3-65

down from the original 512 bits per second (bps) to 256 bps on ground command. As the spacecraft travels farther from Earth its rate of transmission is further reduced: at 100 days to 64 bits per second, at 125 days to 16 bps, and at 150 days to 8 bps.

PIONEER PROJECT TEAM

NASA's programs for unmanned investigation of space are directed by Dr. Homer E. Newell, Associate Administrator for Space Science and Applications. Oran W. Nicks is the Director of OSSA's Lunar and Planetary Programs and Glen A. Reiff is the Pioneer Program Manager. Andrew Edwards is Program Engineer at NASA Headquarters and Dr. Edward Gaugler is Program Scientist.

T. B. Norris is Delta Program Manager for OSSA's Launch Vehicle and Propulsion Programs.

NASA has assigned Pioneer Project management to the Ames Research Center, near Mountain View, Calif. H. Julian Allen is Director of the Ames Center and Robert M. Crane is Assistant Director for Development at the Ames Research Center with over-all responsibility for Pioneer.

Charles F. Hall is Pioneer Project Manager and Howard F. Matthews is Assistant Project Manager, both of Ames.

Dr. John H. Wolfe of the Ames Center Space Sciences Division is Pioneer Project Scientist.

The Pioneer project is divided into four systems: spacecraft, launch vehicle, scientific experiments and the Deep Space Network.

Two of these systems, spacecraft and scientific experiments are managed by Ames. The launch vehicle system is managed by Goddard Space Flight Center and the Deep Space Network is managed by the Jet Propulsion Laboratory.

The Pioneer Project Office at the Ames Center includes 45 people, and ten people from the Ames Systems Engineering Division have been assigned full time to Pioneer. Various Ames divisions are providing support.

Ames Research Center people with Pioneer responsibilities are:

Howard F. Matthews -- Flight Operations and Data Processing
Ernest J. Iufer (Systems Engineering Division) -- Magnetic Characteristics
Robert U. Hofstetter -- Launch Vehicle and Launch Operations. Trajectory Analysis
John R. Mulkern (Systems Engineering Division) -- Quality Assurance and Reliability
Eldon W. Kaser (Procurement and Supply Division) -- Contracts
Donald B. McKellar -- Reports and Budget
Lewis W. Dickerson -- Orientation Operations
Arvid S. Natwick -- Data Processing
Carl H. Keller (Systems Engineering Division) -- Mission-Dependent Ground Equipment

Ralph W. Holtzclaw -- Spacecraft Systems Manager
Myles D. Erickson -- Assistant Spacecraft Systems Manager
George J. Nothwang -- Spacecraft Test Program

Herbert V. Cross -- Scientific Experiments Systems Manager

Spacecraft contractor for the Pioneers is TRW Systems, Redondo Beach, Calif., an operating group of Thompson Ramo Wooldridge, Inc. President of TRW Systems is Dr. Ruben F Mettler and Vice President for Spacecraft Systems Program Management is Dr. Adolph K. Thiel. Pioneer Program Director is Dr. Aubrey G. Mickelwait.

Assistant Program Directors for Pioneer at TRW Systems are:

Robert Zacharias -- Systems Engineering
James H. Allen -- Fabrication
George J. Sidio -- Integration and Test
Dr. Nathaniel L. Sanders -- Experiment Integration
Thomas M. Lough -- Reliability and Quality Assurance
Bernard J. O'Brien -- Program Control

By terms of the fixed-price incentive contract, TRW Systems has, under Ames supervision, produced and delivered the spacecraft to Cape Kennedy. The contract includes multiple incentives on cost schedule, and performance. Performance incentives cover spacecraft weight, magnetic cleanliness, completion of orientation maneuver, and communication lifetime in orbit.

Independent determination of Pioneer spacecraft reliability has been made by Walter V. Sterling, Inc., a reliability assessment firm.

The Pioneer project has procured scientific instruments for this mission developed by scientists from four universities

and two NASA field centers. The scientists responsible are:

Single Axis Magnetometer:

Principal Investigator: Dr. Norman F. Ness, Goddard Space Flight Center.

Plasma Cup Detector:

Principal Investigator: Dr. Herbert S. Bridge, Massachusetts Institute of Technology
Co-Investigators: Dr. Alan J. Lazarus and Dr. Frank Scherb, MIT

Quadraspherical Plasma Analyzer:

Principal Investigator: Dr. John H. Wolfe, Ames Research Center
Co-Investigator: Richard W. Silva, Ames

Radio Propagation Detector:

Principal Investigator: Dr. Von R. Eshleman, Stanford University
Co-Investigators: Dr. Allen M. Peterson and Dr. Owen Garriott, Stanford University; Dr. Ray L. Leadabrand, Stanford Research Institute

Cosmic Ray Anisotropy Detector:

Principal Investigator: Dr. Kenneth G. McCracken, Graduate Research Center of the Southwest
Co-Investigators: Dr. U. Ramachandra Rao and William C. Bartley, GRCSW

Cosmic Ray Telescope:

Principal Investigator: Dr. John A. Simpson, Fermi Institute, University of Chicago
Co-Investigators: Dr. Chang-Yun Fan and James E. Lamport, Fermi Institute, Unversity of Chicago.

The Improved Delta Launch Vehicle is under technical management of the Goddard Space Flight Center, Greenbelt, Md., and launch is directed by the Kennedy Space Center. Fla., including inititial tracking, guidance, and control.

Acting Director of the Goddard Center is Dr. John F. Clark, and William R. Schindler is Launch Vehicle System Manager and Delta manager at Goddard. Director of the Kennedy Center is Dr. Kurt H. Debus; and Robert H. Gray is Assistant Director for Unmanned Launch Operations.

The Delta is built by the Douglas Aircraft Company, Santa Monica, Calif.

NASA's Deep Space Network (DSN) managed by the Jet Propulsion Laboratory, Pasadena, Calif., will conduct a variety of operations in command, tracking, and data acquisition for the Pioneers.

Director of JPL is Dr. William Pickering. John W. Thatcher is Pioneer DSN System Manager.

The DSN stations at Goldstone, Calif., are operated by JPL with the assistance of the Bendix Field Engineering Corp. Walter E. Larkin is Engineer in Charge at Goldstone and Assistant Manager for DSN Operations.

The Tidbinbilla station is operated by the Australian Department of Supply, Weapons Research Establishment. Tidbinbilla Station Manager is Robert A. Leslie and DSN resident is Richard Fahnestock.

The Johannesburg station is operated by the South African government through the National Institute for Telecommunications Research. Doug Hogg is Station Manager and Robert Terbeck is DSN resident.

Spacecraft Subcontractors

Eagle Picher Joplin, Mo.	Batteries
Radio Corporation of America Mountain Top, Pa.	Solar Cells
Optical Coating Labs, Inc. Santa Rosa, Calif.	Solar Cell Cover Glasses
Rantec Calabasas, Calif.	Diplexer and Bandpass Filter
Hughes Aircraft Company Los Angeles, Calif	Traveling Wave Tubes
Electronic Memories, Inc. Hawthorne, Calif.	Data Storage Unit
Vitro Electronics Silver Springs, Md.	Telemetry Receiver
Solid State Products, Inc. Salem, Mass.	Photo Silicon Control Rectifiers
Western Semiconductors Santa Ana, Calif.	Photo Silicon Control Rectifiers
Sterer Engineering and Manufacturing Los Angeles, Calif.	Pressure Regulator and Relief Valve
Weston Hydraulics Van Nuys, Calif.	Pneumatic Solenoid Valve
Quantitron Los Angeles, Calif.	Coaxial Switch

Ground Equipment Subcontractors

Clary Corporation San Gabriel, Calif.	Printer
Ampex Corporation Redwood City, Calif.	Tape Recorder
Astrodata, Inc. Anaheim, Calif.	Data Processing Equipment

Launch Vehicle Subcontractors

Minneapolis-Honeywell, Inc. Minneapolis, Minn.	Autopilot
Texas Instruments, Inc. Dallas, Tex.	Autopilot
Electrosolids Corporation Sylmar, Calif.	Autopilot
Western Electric Company, Inc. Winston-Salem, N. C.	Guidance System

In addition to the firms listed, more than 100 other firms are contributing to the Pioneer spacecraft and its supporting systems.

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